

Phase I Project Summary

Firm: Michigan Aerospace Corporation

Contract Number: NNX13CM19P

Project Title: Volcanic Ash Detection Using Raman LIDAR: "VADER"

Identification and Significance of Innovation:

Volcanic ash is a significant hazard to aircraft engine and electronics and has caused damage to unwary aircraft and disrupted air travel for thousands of travelers, costing millions of dollars. Michigan Aerospace Corporation (MAC) proposes to demonstrate the concept feasibility of a Raman Light Detection and Ranging (LIDAR) system to obtain real-time information from volcanic ash clouds, to be named VADER (Volcanic Ash DETection Raman LIDAR). The instrument will be designed to operate from an airborne platform, and as such, will be compact and light weight. This project will utilize MAC's extensive heritage of rugged LIDAR system design and construction. This technology is also suitable for in-situ aerosol measurements in the atmosphere. The photon budget and instrument design were conducted during the Phase I of this effort and are described in this report. The instrument testing and demonstration will take place in Phase II.

Technical Objectives and Work Plan: All objectives were achieved in this Phase I, including the determination of the operational envelope for VADER and the resulting requirements, the trade studies and photon budgets using models to determine the design parameters of the instrument, and the design the full instrument for prototype fabrication and testing in Phase II.

Technical Accomplishments:

Requirements have been established for both the intended flight envelope as well as the key parameters necessary to determine hazardous conditions. A photon budget has been calculated and the results are currently being verified in the lab through preliminary testing. The instrument design and the algorithms and methods to determine extinction and ash mass concentration are completed.

NASA Application(s): An airborne volcanic ash detection/characterization system, such as VADER, will have wide applications in the study of the threat volcanic ash poses to aircraft and for other scientific study of volcanic plumes. Studies carried out with VADER will allow NASA to refine their models of volcanic ash dispersion based on more data than is available at present. There is potential to combine such a system with MAC's optical air data system and turbulence-detection systems into a unified system that would sense both volcanic and turbulence hazards ahead and report airspeed along with air, temperature and density routinely.

Non-NASA Commercial Application(s):

VADER will have similar utility for non-NASA civil organizations (NOAA, FAA, etc.) and military services (US Air Force, etc.) in conducting scientific studies of volcanic ash characteristics and dispersal. A next generation more-compact VADER would be mountable aboard UAVs to "scout" the airways during major eruptions in order to confirm that aircraft cannot fly or give clearance for flights if the concentrations are not judged high enough to be a threat. With enough data, this will allow commercial and military aviation to continue safely during eruptions without widespread disruptions. Future systems could potentially be mounted aboard commercial and military aircraft as a warning system and/or as part of a unified system gathering data on ash concentrations from wherever the VADER-equipped aircraft are flying, providing even more data for entry into models and for warning purposes. Combined with MAC's optical air data system and turbulence-detection systems, a single system may be devised to detect both volcanic and turbulence hazards ahead and report airspeed along with air, temperature and density routinely, providing commercial aircraft with a valuable new optically-based multi-function warning/air data system. This would increase aviation safety and enhance pilot awareness of the air situation ahead of the aircraft.

Name and Address of Principal Investigator: Dr. Dominique Fourquette, 1777 Highland Drive, Suite B, Ann Arbor, MI 48108-2285

Name and Address of Offeror: Michigan Aerospace Corporation, 1777 Highland Drive, Suite B, Ann Arbor, MI 48108-2285